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DEVELOPING LOCAL RAW MATERIALS AS CORROSION INHIBITORS FOR DRILL-PIPE CORROSION

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Abstract: *This report presents the investigation of red onion skin and the plant Rhizophoraracemosa as inhibitors of corrosion of samples of NST60-2 drill-pipe in drilling mud solution using the weight-loss immersion technique. The inhibitive potentials of the two inhibitors were evaluated based on a determination of the corrosion rates in the presence and absence of the inhibitors and effectiveness of the two inhibitors at different levels of concentrations for room temperature of 28°C and elevated temperature of 125°C. The results show that red onion skin is a much better inhibitor of the corrosion of samples of drill-pipe in drilling mud solution than the plant Rhizophoraracemosa. The effectiveness of inhibition becomes significant only at concentrations of 200ppm for red onion skin and 300ppm for the plant Rhizophoraracemosa at room temperature. At elevated temperature, the effectiveness of their inhibition is not reliable because a greater amount of inhibitor may be required for the protection of oil processing equipment and machineries. The results of this work are expected to be used to improve the corrosion resistance of this drill-pipe for oil processing industries in Nigeria.*

Keywords: Corrosion, Inhibitors, Red Onion Skin, the Plant Rhizophoraracemosa, Drilling Mud.
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INTRODUCTION

Corrosion is the engineers' greatest enemy. Its insidious forms of attack, the tremendous damage it inflicts and the cost of repairs it initiates are only too known to those whose work involves the design, manufacture and maintenance of oil processing equipment. In the oil processing operations, the drilling of crude oil, compressed or liquidfied natural gas and petroleum products are invariably carried out with steel drill-pipes, containers and silos. It is known that once an alloy or steel comes in contact with liquid and gas there is bound to be corrosion which can take any form. Corrosion plays a major role in drill-pipe failure. It has always been a costly problem to mitigate in any manufacturing, production and processing industries. The primary corrodients are inorganic compounds such as water, carbon-dioxide, hydrogen sulphide, nitrogen, sulphuric acid and sodium chloride from the formulation being drilled which dissolve in the drilling mud to form weak acid (Enahora, 1989). This decreases the pH of the drilling mud and results in it being corrosive to drill-pipe and attack most equipment used in refinery operation. Consequent upon this stress corrosion cracking might become a problem. In this work, the effects of tannin inhibitors were investigated in order to evaluate their inhibitive capabilities on carbon steel in drilling mud using weight loss technique. Tannin inhibitors are kind of organic compounds containing functional groups which have been identified as inhibitors for aqueous corrosion of metals such as Al, Fe and Cu (Oni, 1992, Agrawal and Namboodhin, 1992, Bentiss et al, 1999, Bentiss et al 2000). Tannin inhibitors (Austin, 2004) are from two different sources. (i) those extracted from red onion skin and (ii) those extracted from the plant Rhizophoraracemosa. Tannin extracts from red onion skin is purer than that extracts from the plant Rhizophoraracemose (Wikipedia, 2013)

The oil processing industry today is facing many corrosion problems with the materials of construction of their machineries, many of which are fabricated from carbon steel. The problem is traceable to the aggressive nature of the drilling mud. The result of this study therefore is expected to find a solution to this problem in order to increase the life span of the machineries. The development of an effective corrosion inhibitor for petroleum processing operations affords a cost saving benefit for the society.

MATERIALS AND METHOD

Tannin obtained from two different sources namely the red onion skin and the plant Rhizophoraracemosa were selected for this study.

The red onion skin and the plant Rhizophoraracemosa fluids were extracted by squeezing manually, stored differently and varying concentrations of these were prepared in 200ml of drilling mud solution (pH of 5.50) containing dissolved gases for time ranging from 1 day to 14 days. Chemical analysis of part of scrap NST 60-2 drill-pipe used in the experiment was done on Atomic Absorption Spectrometer (AAS) and had the following composition percentages0.35-0.42C 0.02-0.30Si; 0.04-0.9Mn; 0.05S; 0.05P; 0.ION; 0.02Mo; 0.28Cu; 0.03Sn; 0.10Co; 0.10Cr and the rest being Fe. Corrosion coupons measuring 4 x 4cm were constructed. Subsequently each of the coupons was subjected to grinding on emery papers 240, 320, 400 and 600 grits. The oil grease stains on the specimens were removed with acetone. Afterwards, the coupons were weighed on FB 143 Mettle Toledo digital weighing balance and then kept in desiccators for 2 days to allow the oxide film on the surface reach steady state. Different concentrations (100, 200, 300 and 400 ppm) of inhibitors were prepared and added to the environment. Then another medium without any inhibitor was used as the control experiment. Specimens were weighed in turn and their original weights recorded. They were then totally immersed in 200ml of drilling mud solution containing mixture of different concentrations of inhibitors for each container. The specimens were removed after every 2 days and weighed after cleaning off the corrosion products, this lasted for 14 days. The corrosion product formed on the surface of each specimen was removed by scrubbing under running water using fine emery paper. The specimens were then dried, re-weighed and the corrosion rates calculated in mils per year (mpy). The corrosion rates have been calculated in mpy using the expression (Olorunniwo et al, 2009)

$$mpy = \frac{87.6W}{D\,AT} \quad \text{----------------} \quad (a)$$

where, W is the weight loss in mg, D is the density of the specimen in g cm^{-3} , A is the total exposed surface area of the specimen in cm^{-2} and T is the exposed time in hours. The experimental work was carried out for samples of drill-pipe at room temperature of 28°C and also at elevated temperature of 125°Cin the materials Laboratory of the Department of Metallurgical Engineering, Kwara State Polytechnic, Ilorin, Nigeria.

RESULTS AND DISCUSSION

The relationships between corrosion rates and exposure in days are shown in Figs. 1 – 4 in drilling mud solution. The curves of fig 1 shows that in drilling mud solution, red onion skin causes a continuous decrease in corrosion rates with increase in inhibitor concentration at a concentration range of 100ppm and 200ppm at room temperature of 28°C. After a critical inhibitor concentration of 200ppm, no appreciable decrease in corrosion rates occurs. The curves in fig. 2 show that plant Rhizophoraracemosa causes a significant decrease in corrosion rates with increase in inhibitor concentration in the test solution at a concentration range of 100ppm and 300ppm at room temperature of 28°C;. Above 300ppm, no significant decrease in corrosion rate is observed. This shows that the effectiveness of these inhibitors depends on their concentrations. In Figs 3 and 4, a gradual decrease in corrosion rate in the solution occurs at elevated temperature of 125°C as red onion skin and plant Rhizophoraracemosa concentration is maintained within the range of 100 and 300ppm. At critical inhibitor concentrations of 400ppm, red onion skin and plant Rhizophoraracemosa cause a sharp drop in corrosion rate because the presence of these inhibitors tends to influence the ease of passivation on the metal surface.

Examination of the curves in figs 1 – 4 shows that the inhibitive power in the test solution declines from red onion skin to plant Rhizophoraracemosa. It is observed from the data that red onion skin is more effective as corrosion inhibitor in drilling mud solution than plant Rhizophoraracemosa. The reason for this is that tannin extracts from red onion skin is purer than that extracts from the plant Rhizopheraracemosa. The result also indicates that the presence of red onion skin influences the tendency towards passivation of metal surface only after the concentration of 200ppm, while plant Rhizophoraracemosa is active above 300ppm. Hence it could be deduced that the ease with which red onion skin influences ferrous corrosion inhibition relative to plant Rhizophoraracemosa is high. The increase in corrosion in figs 1 – 4 for at low concentration can be explained as being due to the inability of the inhibitors to effectively plug all corrosion sites. This ineffective coverage, results in large cathodic sites in contact with relatively small anodic sites (Alagbe, 2016).

This leads to an increase in corrosion rate, since large amount of oxygen is supplied to the cathodic site thereby speeding up the cathodic reaction (oxygen reduction). In response to this, the anodic reaction (metal dissolution) increases. The high temperature in the drill-pipe material may render film un-protective. The breakdown of the protective film at high inhibitor concentration may be viewed as follows: ferrous ions are first oxidized to ferric hydroxide or oxide by the inhibitor within the pores of the original surface film. This results in partial corrosion inhibition. If the temperature is high, then energy can dissipate itself by the grain-boundary atoms going into solution as ions, that is, the high-energy grain-boundary material is anodic to the rest of the crystal. The breakdown of the film is assumed to occur.

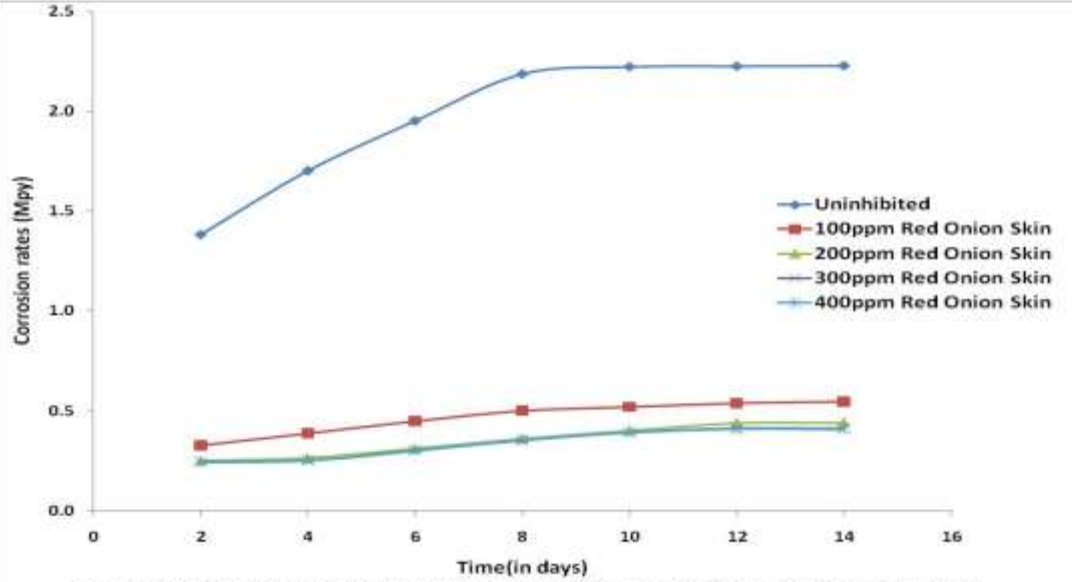

Fig.1: Relationship between corrosion rates of scrap drill-pipe and immersion time in drilling mud solution containg different red onion skin concentrations at room temperature of 28^{0}C

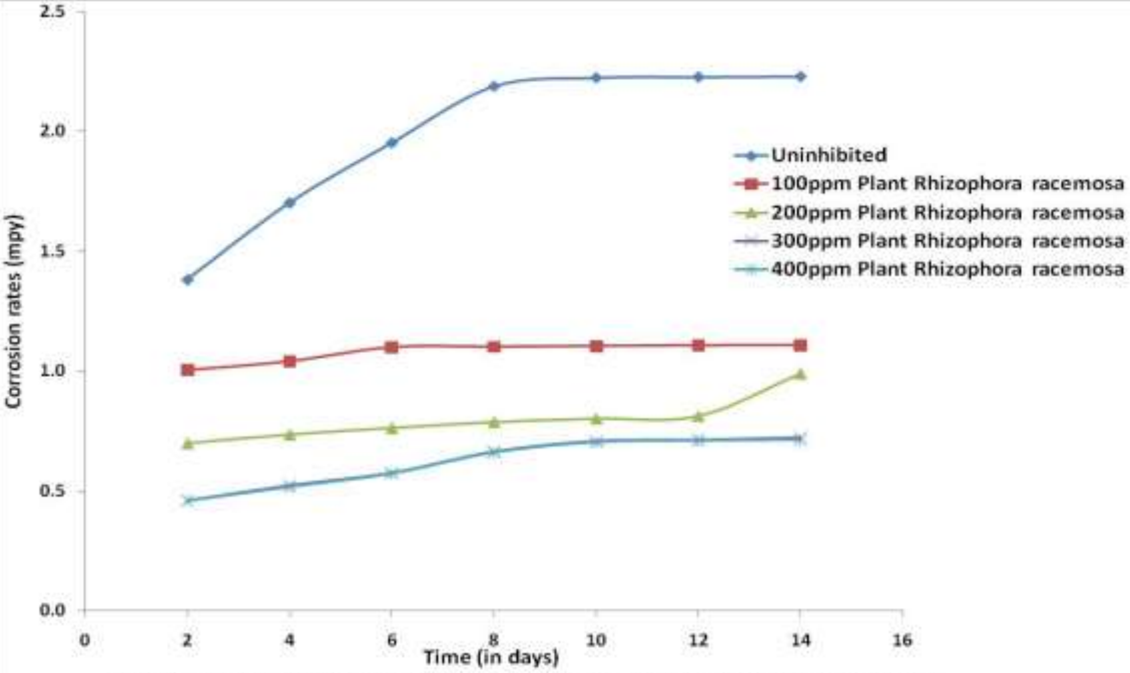

Fig.2: Relaationship between corrosion rates of scrap dril-pipe and immersion time in drilling mud solution containing different plant Rhizophora racemosa concentrations at room temperature of 28^{0}C

Racemosa Concentrations

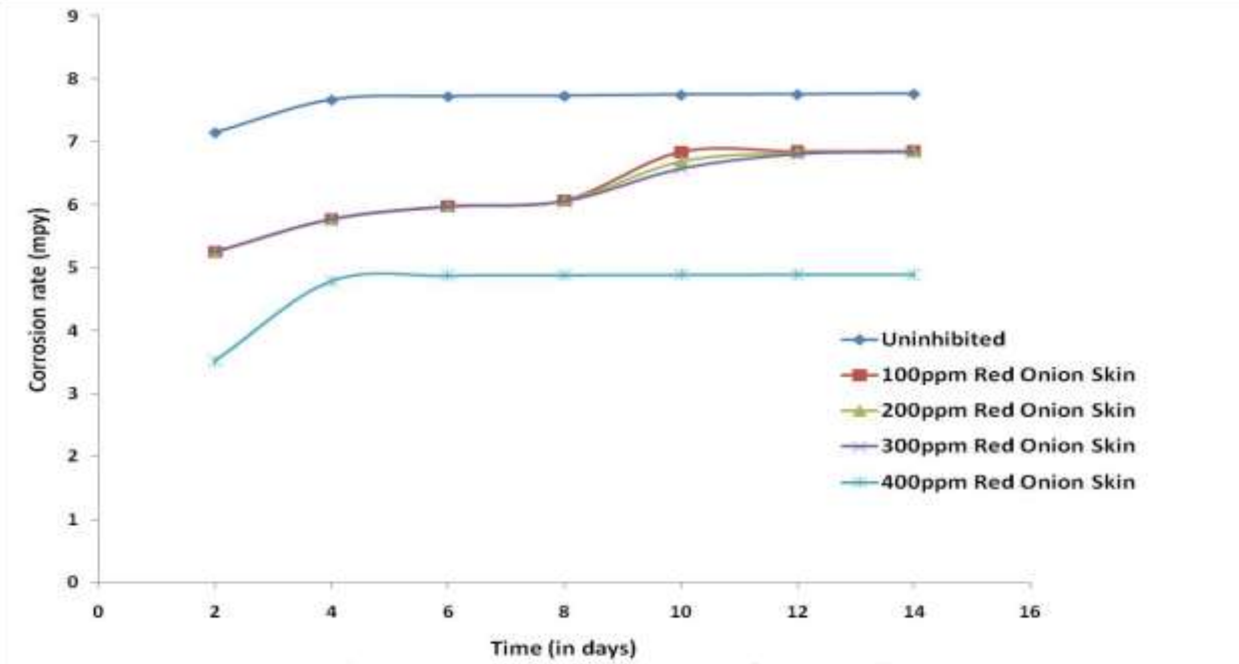

Fig.3: Relationship between corrosion rates of scrap drill-pipe and immersion time in drilling mud solution containing different red onion skin concentration at room temperature of 125^{0}C

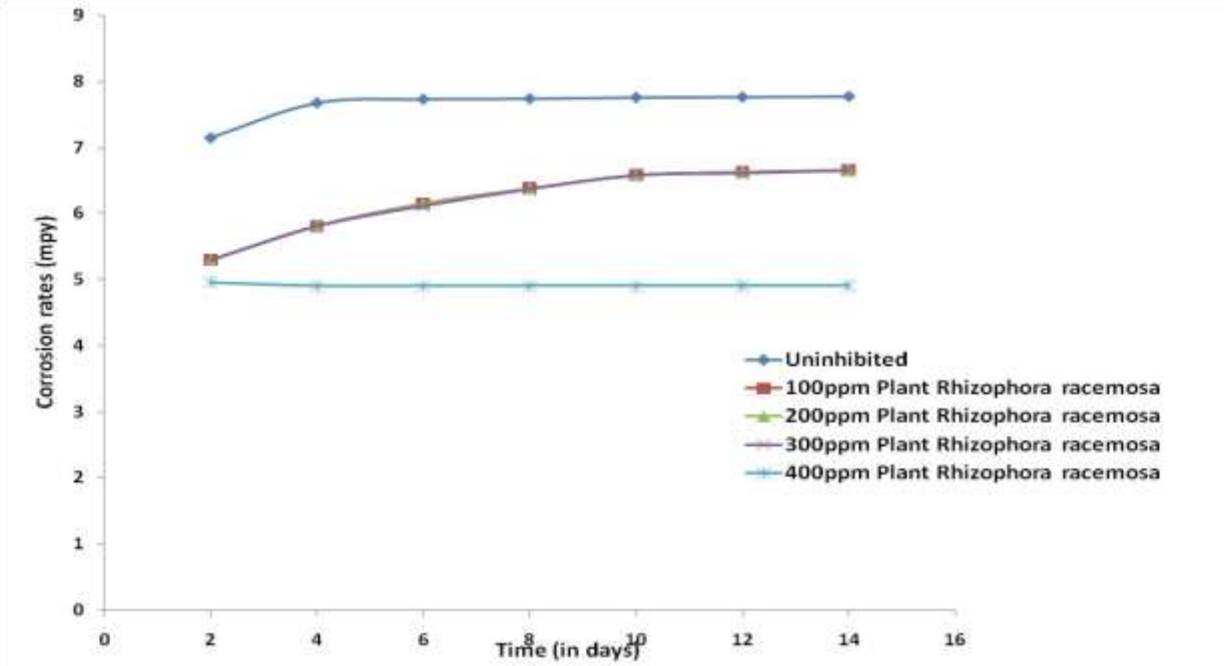

Fig.4: Relationship between corrosion rates of scrap drill-pipe and immersion time in drilling mud solution containing different plant Rhizophora racemosa concentrations at elevated temperature of 125^{0}C

CONCLUSIONS

It may be concluded therefore that from the weight- loss technique used in this study, at both room temperature of 28°C and elevated temperature of 125°C sample of drill-pipe immersed in drilling mud solution containing dissolved oxygen, hydrogen sulphide and corbon-dioxide gasses corrode. It was most effectively inhibited by red onion skin, followed by the plant Rhizophoraracemosa. Though red onion skin and plant Rhizophoraracemosa were both tannin inhibitors the higher inhibition exhibited by red onion skin may be attributed to the tannin extracted from red onion skin being purer than that extracted from the plant Rhizophoraracemosa. The inhibitive capabilities of red onion skin and the plant Rhizophoraracemosa decreased at higher temperature. Hence these inhibitors are temperature dependent and therefore, can only be used at low operating temperature e.g. surface condition and not in reservoir condition.

REFERENCES

Agrawal, R and Namboodhiri, I. (1992): The Inhibition of Corrosion and Hydrogen Embrittlement of AISI 410 Stainless steel, J. Applied Electrochem. Vol. 22, p.383.

Alagbe, M., (2016): Inhibition of NST-44 Mild Steel Corrosion by some inorganic substances in 0.1M Ammonium Nitrate solutions. J. of Engineering and Applied Scientific Research, Vol. 8, No. 1, P. 67 – 74

Austin, D.F. (2004): Florida Ethnobotany CRC Press. En.wikipedia. org/wiki/Rhizophora p.964.

Bentiss, F., M. Traisnel and M. Lagreenee (2000): Inhibitor effects of triazole derivatives on corrosion of mild steel in acidic media. Br. Corrocsion J., 35: 315 – 320.

Bentiss, F. M. Traisnel and J. C. Hornez (1999): The corrosion inhibition of Mild steel in acidic media by a new triazole derivative. Corrosion Sci., 40: 391.

Enahora, C. A. (1989): a corrosion in the Petroleum and Related Industries".
In Proceedings, Nigerian Corrosion Association p. 190.

Olorunniwo, O.E., Umoru, L.E. and Atanda, P.O (2009): Proceedings of First National Conference of Faculty of Technology, Obafemi Awolowo University, Ife-Ile, p. 151 – 154.

Oni, A. (1992), "Some Observations in a Preliminary Study of Inhibition of Cyanic Acid Corrosion By Some Amino Acid Derivatives ". In Proceedings of Nigerian Corrosion Association P. 147-149.

Wikipedia, (2013); en.Wikipedia, org/wiki/Galic-acid.

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